WE have received the first number of "The German Quarterly Magazine; a Series of Popular Essays on Science, History, and Art." The plan of the publication is to give in English such essays, selected from the "Sammlung gemeinverständlicher wissenschaftlicher Vorträge," edited by Profs. Virchow and Franz von Holtzendorff, as are likely to interest the English reading public, and also original contributions; the numbers presenting alternately selections from the departments of Science, History, and Art. The present number contains three papers:—"The Cranial Affinities of Man and the Ape," by R. Virchow; "Sight and the Visual Organs," by A. von Graefe; and "The Circulation of the Waters on the Surface of the Earth," by H. W. Dove; all papers of great interest and importance, but losing something to the English reader from the German phraseology in which the translations are clothed. They are illustrated by good woodcuts, and the subscription to the magazine is 10*s.* per annum.

MESSRS. LONGMAN & CO. are about to publish a volume by Mr. Serjeant Cox, entitled "Spiritualism answered by Science," in which he will detail the arguments that satisfied himself and the other scientific investigators that the phenomena of alleged "Spiritualism" are purely physical, and in no manner associated with spirits of the dead.

DR. BESSELS, the director of the scientific corps of Captain Hall's steamer *Polaris*, in a letter addressed to the president of the American National Academy of Sciences, dated Godaven, August 16, states that he had already made some important observations in regard to the physics of the northern seas, such as a peculiar coloration of the water and an unexpectedly high specific gravity, the maximum density noticed being 1·028. His experiences with his colleagues, Mr. Bryan, the astronomer, and Mr. Meyer, the meteorologist, have been very satisfactory; the former gentleman having made a number of successful azimuth observations, and the latter approving himself an excellent mathematician and an accomplished observer, and an honour to the Signal Service, from which he was detailed for duty with Captain Hall.

THE recently published report of Commissioner R. W. Raymond upon statistics of mines and mining in the states and territories west of the Rocky Mountains for the year 1870, forms a stout volume of nearly 600 pages, illustrated by a number of plates and sections, embodying the result of a laborious personal examination, and that of several assistants. The report contains a detailed account of the present condition of the mining industry in California, Nevada, Oregon, Idaho, Montana, Utah, Arizona, New Mexico, Colorado, and Wyoming, together with interesting statements in regard to improved metallurgical processes, such as especially relate to the treatment of auriferous ores, the chlorination and smelting of silver ores, &c. There are also chapters on narrow-guage railways and their adaptation to mining regions, the mining law, the geographical distribution of mining districts, the origin of gold ingots and gold-dust, and the bullion product. The Commisioner congratulates the country upon an increased prosperity in the mining industry, as seen not only in an augmented bullion product, but an improved tone in the business itself, and relief from more or less of the irritating and burdensome questions that have hitherto been connected with the mining interest. Although the excitements which so frequently carry off the miners and settlers of one region into a new locality have been comparatively rare, yet there have been a few of special note. Among these mentioned by Mr. Raymond are those caused by the discovery of gold in Southern California, near San Diego; the discovery of silver in the Burro Mountains, and the rumours of rich placers on Peace River, far into the interior of British Columbia; the bars of Snake River; several localities in Nevada, and others in Utah; the silver mines in the Caribou district of Colorado, &c.

COLDING ON THE LAWS OF CURRENTS IN ORDINARY CONDUITS AND IN THE SEA

III.

LET us now direct our attention to the polar currents, and especially to that one which from Spitzbergen proceeds to the south-west along the coast of Greenland as far as Cape Farewell. It will be seen that this current has received an impulse from the force of rotation, and rises about one foot towards the west coast of Greenland, an effect which however ceases as soon as it has passed the southern point of that country. As soon as the resistance which compelled the current to follow the line of the coast in proceeding to the south-west disappears, it can no longer continue in the same course, but takes a westerly direction towards Labrador, partly in consequence of the rotation of the earth, partly because the level of the current is then higher than that of the waters of Davis Strait. After having advanced a little into the strait, the polar current encounters the currents coming from the north by Baffin's Bay, and joins them in their progress to the south-east along the coast of Labrador, towards which it slopes in virtue of the rotation of the earth. During this passage, and until its arrival in the neighbourhood of Newfoundland, this current is stemmed by the force of rotation, and ought, consequently, to present a slope all along Davis Strait and the east coast of Newfoundland as far as the Gulf Stream. During its course southwards along this course, the polar current is elevated towards the land by the earth's rotation; but as soon as it has passed Cape Race, this resistance suddenly disappears, and the same phenomenon is reproduced as at Cape Farewell. The current bends suddenly to the south-west, and follows the coast as far as Florida, while its breadth and the volume of its water continue to diminish.

From Newfoundland to Florida, a distance of about 500 miles, the Gulf Stream and the polar current flow constantly side by side, under the impulse of the earth's rotation, which raises the polar current towards the land and compels it to follow all the ins and outs of the coast. But what force is it that impels the Gulf Stream, which flows freely in the ocean, to keep by the side of the polar current in all its windings, instead of taking the more easterly direction, which the rotation of the earth tends to give it? It is, of course, gravity, to wit, the force resulting from the slope which the Gulf Stream presents from right to left perpendicular to its direction throughout its entire breadth, a slope which is 1·2 feet from the point where the current debouches into the Atlantic to New York, and about one foot from New York to the place where, after having approached the shores of Europe, it separates into two branches. And if it be asked why the Gulf Stream has this slope; the reason evidently is that the water of the polar current has a specific gravity greater than the water of the Atlantic, and ought consequently to have a lower level than that of the latter sea, since the water beneath is in equilibrium. That this is the real state of the matter is fully confirmed by the researches made in recent years in the Gulf Stream at the instigation of the American Government, and which leave no room to doubt that this current has not kept its place on account of the difference of density which exists between the waters of the polar current and those of the Atlantic. Under these circumstances it is easy to see that the Gulf Stream ought to follow all the sinuosities of the polar current as far as Newfoundland.

But while the Gulf Stream ought thus to be considered as presenting a uniform slope from the Atlantic towards the polar current, the researches undertaken by the American Government prove that the bottom of the Gulf Stream could be in equilibrium only if that current had an inclination directed away from the polar current towards the Atlantic, such that its maximum level would be nearly one-third of the distance from the polar current. Under the actual conditions, then, there is no equilibrium. The waters of the polar current exercise upon the Gulf Stream a pressure which increases with the depth, and causes a continual afflux of cold water, especially in its lower depth. In proportion as these cold waters penetrate into the Gulf Stream, it communicates to them its heat and its motion, and in proportion as it is raised under the influence of the pressure of the polar current driving away the water which it displaces, its breadth ought to go on increasing. But in order that the breadth of the Gulf Stream may increase, it is necessary that its level in the centre of the current be elevated above that which corresponds to the equilibrium of the surface, so that the force of rotation should acquire the preponderance necessary to produce an enlargement of breadth towards the east; and this elevation of the level gives birth at the same time—from the middle of the Gulf Stream to the polar current—to the surface current of warm water which has been ascertained to exist by the American Commission.

It follows then from what precedes, that on the one hand the polar current penetrates at all points into the Gulf Stream, nearly as far as its surface, which sends to the polar current a surface-current of warm water from twenty to fifty fathoms deep; and, on the other hand, that the Gulf Stream ought, throughout the whole of its depth, to exercise upon the waters of the Atlantic a pressure which forces them to give place to those which it receives from the polar current, and which it draws along with it.

The researches which have recently been made as to the Gulf Stream all appear to confirm these conclusions, so that if we suppose that the volume of the Gulf Stream is increased by all the water which the polar current loses in its course, it will follow that if we designate by Q the volume of the Gulf Stream at Bemini, and by q that of the polar current in any section between Newfoundland and Florida, the volume of the Gulf Stream, for the same section, will be equal to $Q + q$. After that, it is necessary that the polar current—which, from the east coast of Newfoundland, flows towards the Gulf Stream, and from Cape Race takes a south-westerly direction along the American coast—gives up in its passage towards Florida all its water to the Gulf Stream. If, then, we assume the speed of the polar current to the south of Newfoundland to be 1·8 feet per second, its breadth 50 miles, and its depth 900 feet, it will be found that its delivery per second is 1,600,000,000 cubic feet, which makes that of the Gulf Stream to the south of Newfoundland 3,200,000,000 cubic feet per second.

From the southern part of the North Atlantic, then, between the equator and 30° of latitude, it discharges at the rate of 1,600,000,000 cubic feet per second; but besides the loss which has been accounted for, there is another which is due to evaporation; the latter deprives the Gulf Stream of a quantity of water greater than that which falls into it in the form of rain, and which flows into it from the neighbouring lands. To calculate this difference, we can make use of the results of the researches which were made in 1860 at St. Helena by Lieut. Haughton. We thus find that the excess of evaporation in the Atlantic, between 0° and 30° of latitude, is equivalent to a mean height of water of 0·22″, which, after deducting one-tenth for the water which comes from rivers, gives a loss of 50,000,000 cubic feet per second. The total quantity of water, then, which passes from the Atlantic between 0° and 30° of N. latitude, can be stated as equal to 1,650,000,000 cubic feet per second.

If we then admit that two-thirds of all the surface of the lands situated to the north of the 30th degree of latitude send directly or indirectly their waters to the Atlantic, and if we estimate the quantity of rain which annually falls upon that surface, the north part of the Atlantic will receive per second an addition of 50,000,000 cubic feet of water, or, about the same quantity which is carried off by evaporation from the south part between 0° and 30° of N. latitude.

But it follows hence that since the southern branch of the Gulf Stream is formed by the water which flows from the south part of the North Atlantic, it ought to have a delivery of 1,650,000,000 cubic feet per second; and, as the delivery of the entire current, after having passed Newfoundland, may be stated at 3,250,000,000 cubic feet, it follows that that of the northern branch is 1,600,000,000 cubic feet, while the united polar currents ought to represent a volume of 1,650,000,000 cubic feet per second. At St. Augustine the depth of the Gulf Stream is about 300 fathoms, which goes on diminishing regularly, as far as Newfoundland, where it is 1,000 feet. From Newfoundland, where it has a breadth of eighty miles and a speed of two feet, the current proceeds E.N.E., with a decreasing speed and an increasing breadth; at the end of 300 miles it has a depth of 200 and odd fathoms, a speed of 0·6 feet, and a breadth of 200 miles. Moreover, during this part of its course it rises about 2 feet above its level at Newfoundland. Until it attains this height, the Gulf Stream forms only a single current maintained by the fall of 1 foot, which it presents from right to left; but as soon as it reaches that, its southern part presents a slope sufficient to give birth to a branch which proceeds to the south-east, towards the African coast, at a speed of 0·6 feet, and with a delivery of 1,650,000,000 cubic feet per second. When the latter current reaches the 30th degree of N. latitude, it meets the north-east trade-wind, which urges it towards the south.

But while the southern half of the Gulf Stream proceeds towards the south, its northern half, whose delivery per second is 1,600,000,000 cubic feet, pursues its course towards the north, along the shores of Great Britain, as far as the 60th degree of latitude in this passage, during which the current rises towards the land and gradually increases in breadth from 100 to 150 miles, while its speed diminishes from 0·6 to 0·3 of a foot per second, it is subjected to the impulse of the earth's rotation, and its western margin, which naturally blends with the surface of the Atlantic, is raised from $1\frac{1}{3}$ foot through a course of 140 miles, so that at the 60th degree of latitude this side is $3\frac{1}{3}$ feet above the level of the ocean at Newfoundland.

After the Gulf Stream, which throughout this course has a depth of from 200 to 300 fathoms, reaches the north coast of Scotland, about two-thirds of its waters proceed eastwards towards the Norwegian coast, while the other third runs against Iceland, and afterwards continues its course to the north-west to the polar current of Greenland. The latter branch, which the force of rotation raises towards the land, has a depth of 200 and odd fathoms, and a breadth of about 50 miles; in order to be able to advance towards the polar current with a speed of about 0·3 feet per second, a fall of nearly half a foot is necessary. If next we remark that the northern Gulf Stream, towards the north point of Scotland, presents an elevation of 1·5 foot towards the land, we shall easily see that the branch of the Gulf Stream, which proceeds to the north-west, has, along the Icelandic coast, a level which exceeds by half a foot the southern margin of the same current. From this it follows that the waters which skirt the coast of Iceland encounter the polar current on the west of that island at a level higher by $3\frac{1}{3}$ feet than the surface of the Atlantic at Newfoundland. But while these waters advance towards the polar current in virtue of the above-mentioned fall, those of the southern margin of the Gulf Stream have precisely the same level as the polar current. The waters of the western side of the north branch of the Gulf Stream, which are forced to bend towards the west after having reached the 60th degree of north latitude, cannot then continue their course towards the polar current; they spread themselves over the surface of the Atlantic and take a southerly course towards Newfoundland, on account of the difference of level. With regard to those parts of the current situated between the north and south boundaries of this branch of the Gulf Stream, they are, according to their position, drawn for a shorter or longer time still towards the polar current, before taking their course towards the south; and it is thus evident that the warm current must spread itself over the whole surface of the Atlantic between the Northern branch of the Gulf Stream and the polar current which descends from Greenland.

If next we turn our attention to the progress of the polar current from the east coast of Greenland, starting from the following data, viz., that the eastern margin of this current, about 65° north latitude, on the west of Iceland, has a level of $3\frac{1}{3}$ feet higher than that of the Atlantic at Newfoundland, and that it pursues a course to the south-west at the rate of $\frac{3}{4}$ of a foot per second—we see clearly that it is obedient to the impulse communicated by the rotation of the earth. Moreover, let us estimate, after Irminger, the breadth of the current at 40 miles, and suppose that the half of the water which the Gulf Stream carries into the icy sea, as well as the half of that which falls in the form of rain or snow, returns towards the south with the current, while the other half descends by Baffin's Bay; we then find that the force of rotation raises the polar current, whose depth may be estimated at 1,000 feet, one foot above its eastern margin, and, regarding the speed as constant as far as the south point of Greenland, we arrive at the result that, along its eastern side, which naturally blends with the Atlantic, its surface must continue to rise as far as Cape Farewell, from $3\frac{1}{3}$ to 5 feet above the level of the ocean at Newfoundland. If, after having doubled Cape Farewell, the Gulf Stream descended straight towards Newfoundland, the water in Davis Strait ought to rise to a height sufficient to hinder the current from moving in a more westerly direction. But, as the water in Davis Strait cannot have a higher level than is necessary to impel towards the south the tributary bodies of water as rapidly as they join it, and, as for this purpose, at the 63rd degree of north latitude, an inclination of only $3\frac{1}{2}$ feet above the level of the sea at Newfoundland is required, the polar current, on arriving at Cape Farewell, presents towards Davis Strait a slope of $2\frac{1}{2}$ feet along the Greenland coast, and a foot and a half along its opposite margin, and in consequence of this slope proceeds several degrees into the Strait. But as Baffin's Bay and Davis Strait, as has been said before, are traversed by a polar current descending towards the south-east, it ought to have an inclination in that direction; and it is on this account that the current from the east coast of Greenland, after advancing for some time into Davis Strait, is forced to run westwards towards the coast of Labrador, along which it then flows southwards after joining the current from Baffin's Bay. The two united polar currents, whose delivery may be estimated at 1,200,000,000 cubic feet per second, have a breadth of fifty miles, a speed of $\frac{5}{6}$ of a foot per second, and a depth of about 250 fathoms. They flow to the south-east, under the influence of the earth's rotation, which raises them towards the coasts of Labrador and Newfoundland, and continue their course along the latter towards the Gulf Stream until they have doubled Cape Race, when they bend westward and make for Florida.

If now we return to the warm current which, from the Gulf Stream, curves round the south of Iceland, and then spreads itself gradually over the cold waters of the Atlantic, we see that on its arrival at the south point of Greenland, it rises from left to right, from the Gulf Stream to Cape Farewell, about $2\frac{1}{2}$ feet, which shows clearly that its course is really to the south. Moreover, this elevation from left to right enables us to give a more satisfactory account of the conditions of currents. In short, the western margin of the warm current accompanying the polar current, ought, along the latter, to have a depth of 1,000 feet and a speed of $\frac{3}{4}$ of a foot; and as the speed of the current diminishes regularly in approaching the Gulf Stream, and as all the parts of the current follow, as far as Cape Farewell, a direction nearly parallel, it follows that the speed along the Gulf Stream ought to be at the rate of about $\frac{1}{2}$ a foot per second. But if the returning branch of the Gulf Stream proceeds to the south-west with a fall of $\frac{1}{2}$ a foot on its west border, it follows that the depth of the current ought to be 76 feet. By determining in the same way the depth for a certain number of points of a transverse section, and by calculating according to these data the total delivery of the current, we find that it is raised to 410,000,000 cubic feet per second, which perfectly accords with the result which we ought to obtain. If next we inquire how the various parts of the warm surface current move under the united action of the slope and the earth's rotation, we ascertain that this current ought to follow the course of the polar current which gradually absorbs the waters that penetrate underneath, the water of the current being more dense than that of the polar current, and we find at the same time that in thus flowing towards the polar current the water ought to spread itself all over the Atlantic as far as Newfoundland.

After having thus shown that the preceding theory accounts in a tolerably complete manner for all the movements of the ocean currents, I shall add, in conclusion, that it is very possible, considering our imperfect knowledge of the progress of currents, that many details may be very different from those which have been expounded above; but, so far as the main question is concerned, I believe I am entitled to say with confidence that the laws of ocean currents are pretty much those which I have attempted to establish.

That these laws are equally applicable to the atmospheric currents is evident, and it is scarcely necessary to repeat, that in periods when the differences of temperature on the surface of the globe were greater than at present, all these currents were much stronger, and of a nature otherwise very energetic.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopical Science* for October, 1871. "The origin and distribution of Microzymes (Bacteria) in water, and the circumstances which determine their existence in the tissues and liquids of the living body," by Dr. Burdon Sanderson, F.R.S. This paper is occupied chiefly by details of experiments to determine the conditions which are fatal or favourable to the existence of microzymes in the liquid or gaseous fluids by which we are surrounded, in order to approach one degree nearer to an understanding of their influence on the processes which go on in the living body. After a definition of "microzymes" the author proceeds to their chemical composition and their relation to the media in which they grow. This portion is brief and incomplete. The remainder of the paper is occupied with the experiments, which are grouped under these three sections. (1) Experimental determination of the conditions which govern the development of microzymes in certain organic liquids to be used as tests. Having found in a number of cases that either contact with surfaces which had not been superheated, or the admixture of water which had not been boiled, was the exclusive cause of the growth of microzymes in the experimental liquid, it was inferred that water is the primary source from whence the germinal particles of bacteria are derived whenever they seem to originate spontaneously in organic solutions. A number of experiments were made with different varieties of water in ordinary use, in order to confirm the observations already made, and to ascertain if all waters possess the properties in question in a like degree. These experiments are detailed under the second section (2) Distribution of the Germal Matter of Microzymes in ordinary Water. The results under this head were not deemed satisfactory. (3) Circumstances which determine the existence of microzymes in organic liquids and tissues, that is, whether the tissues and liquids of the living body participate in the zymotic property which exists in water and moist substances. The conclusion drawn from the facts is, that "it has appeared certain that there is no developmental connection between microzymes and torula cells, and that their apparent association is one of mere juxtaposition. Thus fungi are not developed, notwithstanding the presence of microzymes in the same liquid in which, microzymes being absent, but air having access, they appear with the greatest readiness." Finally, the writer is certain that, although air is the main source of what he calls fungus impregnation, as distinguished from impregnation with microzymes, yet the two acts may take place at the same moment, germs of torula being often contained in the same liquid media as the germ particles of microzymes.—"On the Colouring Matter of some Aphides," by H. C. Sorby, F.R.S.—"Observations and Experiments on the Red Blood Corpuscles, chiefly with regard to the Action of Gases and Vapours," by E. Ray Lankester.—"On Undulina, the type of a new group of Infusoria," by E. Ray Lankester.—"On the Circulation in the wings of *Blatta Orientalis* and other Insects, and on a new method of injecting the vessels of insects," by H. N. Moseley. After describing the method adopted for preparing and fixing the wings of insects for examination of the circulation, the writer proceeds to his experiences with the cockroach. The corpuscles in *Blatta* are so large that the circulation may readily be seen with a high power of a simple dissecting microscope. If an insect be carefully tied, the circulation may be observed in action for as long as twelve hours. Abundance of parasites were found in the blood vessels of *Blatta* and coleopterous insects. The method recommended for the injection of the circulatory system of insects is through the largest artery on the front border of the wing, and the injecting fluid is indigo carmine.—"On the production of Spores in the Radiolaria," by Prof. L. Cienkowski; translated from vol. vii., part 4, of the "Archiv. für Mikroskop. Anatomie." The observations on which this paper is based were mainly made upon Collosphæra and Collozoum. The capsule is the source of the zoospores. In the mature capsule the contents break up into a quantity of little spheroids.—"On the Peripheral Distribution of non-medullated Nerve-fibres," by E. Klein. The writer purposes treating of the nerves of the cornea, those of the nictitating membrane of the frog, of the canal in the tail of the rabbit, and of the mesentery. The present communication is confined to the nerves of the cornea, the remaining subjects are to be embodied in a second paper.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, Nov. 22.—The Rev. Thomas Wiltshire, M.A., in the chair. Mr. Samuel Baillie Coxon was elected a Fellow of the Society. The following communications were read:—1. "Notes on some Fossils from the Devonian Rocks of the Witzenberg Flats, Cape Colony." By Prof. T. Rupert Jones, F.G.S. In this paper the author noticed some Devonian fossils like those of the Bokkeveld, found on Mr. Louw's farm on the Witzenberg Flats, Tulbagh. *Orthoceras vittatum*, Sandberger, was added to the South African list of fossils. The fossils under notice were stated by the author to help to substantiate the late Dr. Rubidge's view, that the old schists termed "Silurian" by Bain are of Devonian age, and continuous across the colony. Their presence in the Witzenberg Flats was also